

Appendix F

KDOW PAA Pilot Submittal



GRW | engineering | architecture | geospatial
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April 24, 2017

Mr. Greg Goode, P.E.
Env. Engineering Consultant
Water Infrastructure Branch
Division of Water
300 Sower Boulevard
Frankfort, KY 40601

**Re: Brandenburg Wastewater Facilities Plan
 PAA Pilot Study Submittal
 GRW Project No. 4556**

Dear Mr. Goode:

Per our correspondence, the following is a notice of the City of Brandenburg's intention to complete a Peracetic Acid (PAA) Pilot at the existing Brandenburg Wastewater Treatment Plant (KPDES Permit No. KY0021474). The pilot will begin on approximately May 8, 2017 and proceed for six (6) months in order to get results during both wet and dry weather conditions.

Enclosed is a process flow schematic of the Brandenburg WWTP with the treatment train, PAA injection location, skid location, tote location, and sampling location for pilot. The pump during the pilot will be a Blue White M3 peristaltic pump, please see brochure attached. All hard piping is stainless steel and flexible Telfon tubing is used in locations where it's not hard piped. The pumps and piping will be located on a modified ChemPlus Simplex System skid, please see brochure attached. The skid will have a secondary containment for any leaks from the pumps. Lastly, please see attached for the contact times. Contact times for the design average (0.312 MGD), design peak (0.932 MGD), and average 2016 effluent (0.181 MGD) flows are 14.8, 10.6, and 16.9 minutes, respectively. See enclosed for calculations.

If you have any questions or comments, please do not hesitate to contact me at 502-489-8484, or jpavoni@grwinc.com

Sincerely,

A handwritten signature in blue ink that reads "Joseph V. Pavoni". The signature is fluid and cursive, with the first name "Joseph" and last name "Pavoni" clearly legible.

Joseph V. Pavoni, P.E., LEED AP
Project Manager

Enclosure: Process Flow Schematic of Brandenburg WWTP
 Blue White M3 Peristaltic Pump Brochure
 ChemPlus Feed Systems Brochure
 Contact Time Calculations

Cc: Mayor Ronnie Joyner, City of Brandenburg
 T.J. Hughes, Brandenburg Public Works Director

PRINTED: 4/24/2017 @ 10:57AM

FILE NAME: G:\4566-Bburg WW Plan\01-WW Plan Update\Working Drawings\AutoCAD\Existing - Flow Schematic- KDOWN Submittal.dwg

E. COLI SAMPLING
LOCATION DURING PILOT

EXISTING MANHOLE

PLANT EFFLUENT
TO OHIO RIVER

2,000 L.F. OF 15" PVC BETWEEN
DECHLORINATION INDUCTION
STATION AND EXISTING MANHOLE

PLANT INFLUENT

RIVERPORT A

RIVERPORT B

CELL NO. 1

BOX NO. 2

CELL NO. 2

BOX NO. 1

SCREEN CHANNEL

PARSHALL FLUME

CONTROL
BUILDING

CHLORINATION INDUCTION STATION

CHLORINE TO BE TURNED
OFF DURING PILOT

BOX NO. 3

CLARIFIER/CONTACT BASINS

DECANT MANHOLE

SCUM/SLUDGE/DEWATER
PUMP STATION

CHLORINE
ENCLOSURE

SULFUR DIOXIDE
ENCLOSURE

PAA INJECTION LOCATION

BOX NO. 4

PUMP SKID AND TOTE LOCATION
(BOTH HAVE THEIR OWN SPILL
CONTAINMENT)

DECHLORINATION
INDUCTION STATION
SULFUR DIOXIDE TO BE
TURNED OFF DURING
PILOT

BRANDENBURG PAA PILOT
TREATMENT TRAIN

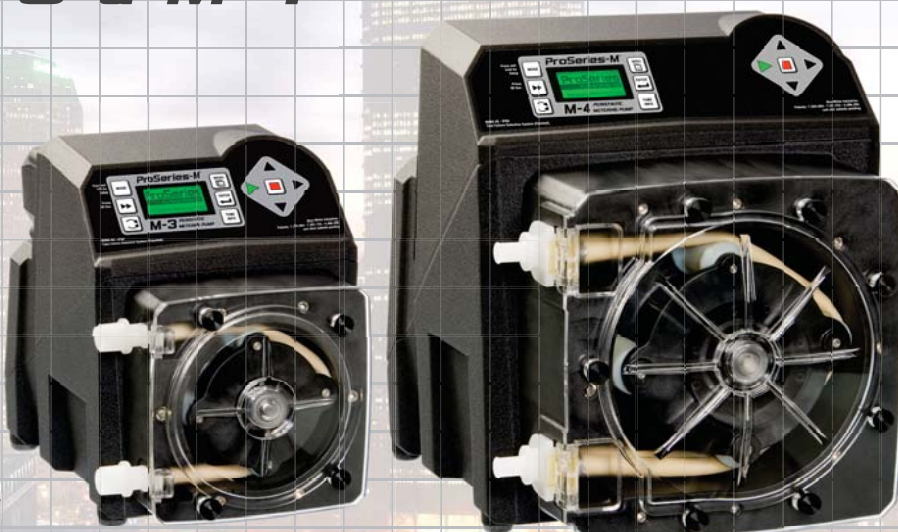
WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY



engineering | architecture | geospatial

FLEX-PRO® M-3 & M-4

10,000:1 Turndown ratio
Tube Failure Detection
Revolution Count Display & Alarm
Brushless DC Motor
NEMA 4X (IP 66) Washdown
NSF Listed Std. 61
5 Year Warranty



Model M-324-MNK

Model M-424-BNL

Sold and serviced exclusively by highly skilled, factory authorized technicians.



NEMA 4X

Patents: 4,496,295, 7,001,153, 8,418,364 and other patents pending

Applications:

- Municipal Water Treatment
- Municipal Wastewater Treatment
- Chemical Metering
- Chlorination
- Chloramination
- Fluoridation
- Polymer Injection
- Acid Injection
- Alum Injection
- PAC Injection
- Caustic Injection

Features:

- Peristaltic pump design does not have valves that can clog requiring maintenance.
- Self priming - even against maximum line pressure. By-pass valves are not required. Cannot vapor lock or lose prime.
- Output rates to: 158.5 GPH (600 LPH) and pressures to 125 PSI (8.6 Bar).
- 10,000:1 turndown ratio with high resolution motor speed adjustment.
- No maintenance brushless variable speed motor.
- Specially engineered tubing for long life at high pressures.
- Patented Tube Failure Detection (TFD) system. Senses tube failure by detecting chemical in the pump head. No false triggering from condensation or washdown.
- Control Inputs include: 4-20mA, 0-10Vdc, and Pulse inputs for remote external speed or batch control and 0-30 VDC / contact closure remote start/stop.
- Revolution count display with user programmable alarm set-point for tube maintenance.
- VGA Graphic multi-color backlit LCD displays remote/local control status, motor speed, output rate, input signal values, service and alarm status in three easy to see colors.
- Outputs include: Scalable 4-20mA or pulse, one 250V/6A relay and three 115V/1A contact closures assignable to monitor various pump functions including TFD, FVS, revolution counter, remote/local, forward/reverse, input signals, output signals, motor on, motor fault, operating mode setting, and others.
- Two CNC precision machined squeeze rollers and two alignment rollers provide factory calibrated optimum squeeze for unparalleled accuracy and extra long tube life.
- Heavy duty rotor - single piece plastic rotor means no flexing and increased accuracy with no metal springs or hinges to corrode.
- Inject at maximum pressure in either direction (clockwise or counter clockwise).
- Compatible with Blue-White's output Flow Verification Sensor (FVS) system.

Engineering Specifications:**Maximum working pressure (excluding pump tubes):**

125 psig (8.6 bar)

Note: see individual pump tube assembly maximum pressure ratings.

Maximum Fluid temperature (excluding pump tubes):

3/8" OD x 1/4" ID tubing connections: 130°F (54°C)

M/NPT connections: 185°F (85°C)

Note: see individual pump tube assembly maximum temperature ratings.

Ambient Operating Temperature

14°F to 115°F (-10°C to 46°C)°

Ambient Storage Temperature

-40°F to 158°F (-40°C to 70°C)°

Operating Voltage:

M-3 MODELS: 96 to 264VAC-50/60Hz, 220 VA

M-4 MODELS: 96 to 264VAC-50/60Hz, 350 VA

Power Cord Options:

115V60Hz = NEMA 5/15 (USA)

230V60Hz = NEMA 6/15 (USA)

220V50Hz = CEE 7/VII (EU)

240V50Hz = AS 3112 (Australia/New Zealand)

Enclosure:

NEMA 4X (IP66), Polyester powder coated aluminum.

Maximum Overall Dimensions:

M-3 models: 8-1/8"W x 10-3/4"H x 15-1/4"D (20.6W x 27.3H x 38.9D cm)

M-4 models: 12-1/8"W x 14-1/4"H x 18-5/8"D (30.8W x 36.1H x 47.3D cm)

Approximate shipping wt:

M-3 models: 33 lb. (15.0 Kg)

M-4 models: 58 lb. (26.3 Kg)

Motor speed adjustment range

10,000:1 (0.001% - 100% motor speed)

Motor speed adjustment resolution

0.1% increments > 10% motor speed

0.01% increments > 1% motor speed and < 10%

0.001% increments < 1% motor speed

Maximum viscosity

12,000 Centipoise

Maximum suction lift:

30 ft. Water, 0 psig (4.5 m, 0 bar)

Display

3 color VGA backlit LCD, UV resistant.

Display resolution

0.0 > 10% motor speed

0.00 > 1% motor speed and < 10%

0.000 < 1% motor speed

Display languages

English, Spanish, French or German selectable.

Keypad

Eleven button positive action tactile switch keypad.

Security

Programmable 4-digit password.

Materials of Construction:

Wetted components:

Pump Tube Assembly (Model Specific - 2 provided):**Tubing:** Norprene® or Norprene® Chemical or Tygothane®**Adapter fittings:** .PVDF

Non-Wetted components:

Enclosure:

413 Aluminum (Polyester powder coated)

Pump Head:

Valox® (PBT) thermoplastic

Pump Head Cover:

Polycarbonate for added strength and chemical resistance.

Permanently lubricated sealed motor shaft support ball bearing.

Cover Screws:

Stainless Steel

Roller Assembly:**Rotor:**.....Valox® (PBT)**Rollers:**.....Nylon**Roller Bearings:**.....SS Ball Bearings**Motor Shaft:**

Chrome plated steel

TFD System Sensor pins:

Hastelloy C-276

Power Cord:

3 conductor, SJTW-A Water-resistant

Tube Installation Tool:

Glass Filled Nylon

Mounting Brackets and Hardware:

316 Stainless Steel

Recommended Ancillary Items Sold Separately:**Injection / Back-flow Check valve:****Body & insert:** PVDF**Check Ball:** Ceramic**Spring:** Hastelloy C-276**Ball Seat O-ring:** Viton® (optional EP)**Static Seal O-ring:** Viton® (optional EP)**Duckbill anti-scale valve:** Santoprene®**For "S" tubing type connections only:**

(Available on M3 only)

Suction Tubing: 3/8" OD x 1/4" ID x 10' Clear PVC**Discharge Tubing:** 3/8" OD x 1/4" ID x 10' Polyethylene (LLDPE)**Suction Strainer:** Polypropylene**For "B" barb tubing and "M" M/NPT connections only:**

(Available on M-4 and M-3 Flex-A-Prene® only)

Suction Strainer:**Body:** PVDF**Check Ball:** Ceramic**Ball Seat O-ring:** Viton® (optional EP)**For "C" Tri-clamp and "Q" Quick Disconnect connections* only:**

(Available on M-3 Flex-A-Prene® only)

Suction Strainer: Polypropylene

*Quick Disconnect Valves sold separately

Output Specifications:

Output Range			Max Speed	Max Pressure	Max Temperature	M-3 Model Numbers		
Norprene® M-3 Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Excellent chemical resistance CIP SIP								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0002 - 2.10	.0007 - 7.92	.0132 - 132	125	125 (8.6)	185 (85)	M-324-*ND	M-325-*ND	M-326-*ND
.0025 - 25.3	.0096 - 96.0	.1596 - 1596	125	125 (8.6)	185 (85)	M-324-*NJ	M-325-*NJ	M-326-*NJ
.0033 - 33.3	.0126 - 126	.2100 - 2100	125	125 (8.6)	185 (85)	M-324-*NK	M-325-*NK	M-326-*NK
.0033 - 33.3	.0126 - 126	.2100 - 2100	125	30 (2.1)	185 (85)	M-324-*NKL	M-325-*NKL	M-326-*NKL
Flex-A-Prene® M-3 Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Excellent chemical resistance Extra long life at low pressures								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0005 - 4.8	.0018 - 18.0	.03 - 300	125	110 (7.6)	185 (85)	M-324-*NEE	M-325-*NEE	M-326-*NEE
.0019 - 19.0	.0072 - 72.0	.12 - 1200	125	110 (7.6)	185 (85)	M-324-*NGG	M-325-*NGG	M-326-*NGG
Norprene® Chemical M-3 Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Superior chemical resistance								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0014 - 14.5	.0055 - 55.1	.0920 - 920	125	50 (3.4)	130 (54)	M-324-*TH	M-325-*TH	M-326-*TH
.0028 - 28.5	.0108 - 108	.1800 - 1800	125	50 (3.4)	130 (54)	M-324-*TK	M-325-*TK	M-326-*TK
Tygothane® M-3 Tube Pumps								
Meets FDA criteria for food Resistant to oils, greases and fuels								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0004 - 4.60	.0017 - 17.4	.0290 - 290	125	65 (4.5)	130 (54)	M-324-*GE	M-325-*GE	M-326-*GE
.0010 - 10.1	.0038 - 38.4	.0637 - 637	125	65 (4.5)	130 (54)	M-324-*GG	M-325-*GG	M-326-*GG
.0024 - 24.9	.0094 - 94.2	.1570 - 1570	125	65 (4.5)	130 (54)	M-324-*GH	M-325-*GH	M-326-*GH
.0028 - 28.5	.0108 - 108	.1800 - 1800	125	65 (4.5)	130 (54)	M-324-*GK	M-325-*GK	M-326-*GK

Output Range			Max Speed	Max Pressure	Max Temperature	M-4 Model Numbers		
Norprene® M-4 Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Excellent chemical resistance CIP SIP								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0028 - 28.5	.0108 - 108	.180 - 1800	125	125 (8.6)	185 (85)	M-424-*NH	M-425-*NH	M-426-*NH
.0044 - 44.4	.0168 - 168	.280 - 2800	125	100 (6.9)	185 (85)	M-424-*NJ	M-425-*NJ	M-426-*NJ
.0050 - 50.7	.0192 - 192	.320 - 3200	125	80 (5.5)	185 (85)	M-424-*NK	M-425-*NK	M-426-*NK
.0054 - 54.0	.0204 - 204	.340 - 3400	125	100 (6.9)	185 (85)	M-424-*NHH	M-425-*NHH	M-426-*NHH
.010 - 100.0	.0378 - 378	.630 - 6300	125	50 (3.4)	185 (85)	M-424-*NL	M-425-*NL	M-426-*NL
.015 - 158.5	.0600 - 600	1.00 - 10000	125	30 (2.0)	185 (85)	M-424-*NP	M-425-*NP	M-426-*NP
Norprene® M-4 Low Pressure Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Excellent chemical resistance Extra long life at low pressures								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0050 - 50.7	.0192 - 192	.320 - 3200	125	30 (2.1)	185 (85)	M-424-*NKL	M-425-*NKL	M-426-*NKL
.011 - 111.0	.0420 - 420	.700 - 7000	125	30 (2.1)	185 (85)	M-424-*NKKL	M-425-*NKKL	M-426-*NKKL
Norprene® Chemical M-4 Tube Pumps								
Listed under NSF Std. 61 Meets FDA criteria for food Superior chemical resistance								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0020 - 20.6	.0078 - 78.0	.130 - 1300	125	30 (2.1)	130 (54)	M-424-*TH	M-425-*TH	M-426-*TH
.0042 - 42.8	.0162 - 162	.270 - 2700	125	30 (2.1)	130 (54)	M-424-*TK	M-425-*TK	M-426-*TK
.0050 - 50.7	.0192 - 192	.320 - 3200	125	30 (2.1)	130 (54)	M-424-*THH	M-425-*THH	M-426-*THH
Tygothane® M-4 Tube Pumps								
Meets FDA criteria for food Resistant to oils, greases and fuels								
GPH	LPH	ML/MIN	RPM	PSI (bar)	F (C)	115V AC	230V AC	220V AC
.0039 - 39.6	.0150 - 150	.250 - 2500	125	65 (4.5)	130 (54)	M-424-*GH	M-425-*GH	M-426-*GH
.0055 - 55.5	.0210 - 210	.350 - 3500	125	65 (4.5)	130 (54)	M-424-*GK	M-425-*GK	M-426-*GK
.010 - 100.0	.0378 - 378	.630 - 6300	125	65 (4.5)	130 (54)	M-424-*GKK	M-425-*GKK	M-426-*GKK

* Inlet/outlet connection types available: **S** = 3/8" OD x 1/4" ID flexible tubing with compression type connections (M-3 models only), **M** = 1/2" male NPT, **B** = 1/2" ID tubing barb type connections (M-3 Flex-A-Prene® and M-4 models only), **C** = 3/4" tri-clamp connections (M-3 Flex-A-Prene® models only), **Q** = Quick Disconnect (M-3 Flex-A-Prene® models only) (**Valves sold separately**) Note: output volumes based on testing with water at 72 degrees F, 5 foot suction lift, atmospheric conditions at sea level.

Engineering and Technical Data

Chemical Resistance of Tubing:

Flex-A-Prene® and Norprene® Tubing

Meets FDA criteria for food | Excellent chemical resistance

Alcohol general	Citric Acid 50%	Hydrochloric acid 33%	Potassium hydroxide
Aluminum Sulfate (Alum)	Ethylene glycol	Hydrocyanic acid	Potassium permanganate 40%
Ammonium chloride	Ferric chloride	Hydrogen peroxide	Propylene glycol
Ammonium hydroxide	Ferric nitrate	Hypochlorous acid	Sodium hydroxide 50%
Ammonium Sulfate (LAS)	Ferric sulfate	Iodine	Sodium Bisulfite
Benzyl alcohol	Ferrous chloride - 43% in water	Magnesium chloride	Sodium Chlorite 12%
Bleach	Ferrous sulfate	Magnesium sulfate	Sodium Hypochlorite 12.5%
Brine solutions	Fluosilicic Acid (up to 25%)	Phosphoric acid	Sodium sulfide
Calcium Hydroxide 10% (Lime Slurry)	Formic acid	Plating solutions	Sulfuric acid up to 50%
Calcium hypochlorite 20%	Glucose	Polyaluminum Chloride (PAC)	Tannic acid

Norprene® Chemical Tubing - Ultra smooth plasticizer-free bore (inner liner)

Meets FDA criteria for food | Superior chemical resistance

Ferrous Chloride (up to 40%)	Phosphoric Acid (up to 85%)	Bases	Applications:
Fluoboric Acid (up to 48%)	Potassium Hypochlorite (up to 70%)	Salts	Ink and solvent production
Fluosilicic Acid (up to 25%)	Sodium Phosphate (up to 30%)	Ketones	Battery acid filling
Hydrofluoric Acid (up to 48%)	Sulfuric Acid (up to 98%)	Alcohols	Specialty chemical production / processing
Nitric Acid (up to 71%)		Isobutyl Alcohol	Sensitive fluid transfer

Tygothane® Tubing

Meets FDA criteria for food | Resistant to oils, greases and fuels

Cyclohexane	Kerosene	Oils:	Oils:
Diesel Fuel	Lard	ASTM reference No.1,2,3	Linseed
Fatty acids	Mineral spirits	Castor	Lubricating
Gasoline	Soap solutions	Coconut	Mineral
Heptane	Turpentine	Fuel	
Hexane			

Norprene® is a registered trademark of Saint-Gobain.
Tygothane® is a registered trademark of Saint-Gobain.

Pump Tube Assembly Output Specifications:

Model M-3 - Available Pump Tubes and Output Ranges

Tube Material	Tube Size	Max Output Pressure	Max Temp	Required Roller Part Number	Output Range		
Material	Code	PSI (bar)	F (C)		GPH	LPH	ML/Min
Norprene	ND	125 (8.6)	185 (85)	A3-SND-R	.0002 - 2.10	.0007 - 7.92	.0132 - 132
Flex-A-Prene	NEE	110 (7.6)	185 (85)	A3-SNEE-R	.0005 - 4.8	.0018 - 18.0	.03 - 300
Flex-A-Prene	NGG	110 (7.6)	185 (85)	A3-SNGG-R	.0019 - 19.0	.0072 - 72.0	.12 - 1200
Norprene	NJ	125 (8.6)	185 (85)	A3-SNH-R	.0025 - 25.3	.0096 - 96.0	.1596 - 1596
Norprene	NK	125 (8.6)	185 (85)	A3-SNH-R	.0033 - 33.3	.0126 - 126	.2100 - 2100
Norprene	NKL	30 (2.1)	185 (85)	A3-SNH-R	.0033 - 33.3	.0126 - 126	.2100 - 2100
Norprene Chemical	TH	50 (3.4)	130 (54)	A3-STH-R	.0014 - 14.5	.0055 - 55.1	.0920 - 920
Norprene Chemical	TK	50 (3.4)	130 (54)	A3-STH-R	.0028 - 28.5	.0108 - 108	.1800 - 1800
Tygothane	GE	65 (4.5)	130 (54)	A3-SGE-R	.0004 - 4.60	.0017 - 17.4	.0290 - 290
Tygothane	GG	65 (4.5)	130 (54)	A3-SGE-R	.0010 - 10.1	.0038 - 38.4	.0637 - 637
Tygothane	GH	65 (4.5)	130 (54)	A3-SGE-R	.0024 - 24.9	.0094 - 94.2	.1570 - 1570
Tygothane	GK	65 (4.5)	130 (54)	A3-SGE-R	.0028 - 28.5	.0108 - 108	.1800 - 1800

Model M-4 - Available Pump Tubes and Output Ranges

Tube Material	Tube Size	Max Output Pressure	Max Temp	Required Roller Part Number	Output Range		
Material	Code	PSI (bar)	F (C)		GPH	LPH	ML/Min
Norprene	NH	125 (8.6)	185 (85)	A4-MNH-R	.0028 - 28.5	.0108 - 108	.1800 - 1800
Norprene	NJ	100 (6.9)	185 (85)	A4-MNH-R	.0044 - 44.4	.0168 - 168	.2800 - 2800
Norprene	NK	80 (5.5)	185 (85)	A4-MNH-R	.0050 - 50.7	.0192 - 192	.3200 - 3200
Norprene	NHH	100 (6.9)	185 (85)	A4-MNH-R	.0054 - 54.0	.0204 - 204	.3400 - 3400
Norprene	NL	50 (3.4)	185 (85)	A4-MNL-R	.0100 - 100.0	.0378 - 378	.6300 - 6300
Norprene	NP	30 (2.1)	185 (85)	A4-MNL-R	.0158 - 158.5	.0600 - 600	1.00 - 10000
Norprene	NKL	30 (2.1)	185 (85)	A4-MNH-R	.0050 - 50.7	.0192 - 192	.3200 - 3200
Norprene	NKKL	30 (2.1)	185 (85)	A4-MNH-R	.0111 - 111.0	.0420 - 420	.7000 - 7000
Norprene Chemical	TH	30 (2.1)	130 (54)	A4-MTH-R	.0020 - 20.6	.0078 - 78.0	.1300 - 1300
Norprene Chemical	TK	30 (2.1)	130 (54)	A4-MTH-R	.0042 - 42.8	.0162 - 162	.2700 - 2700
Norprene Chemical	THH	30 (2.1)	130 (54)	A4-MTH-R	.0050 - 50.7	.0192 - 192	.3200 - 3200
Tygothane	GH	65 (4.5)	130 (54)	A4-MGH-R	.0039 - 39.6	.0150 - 150	.2500 - 2500
Tygothane	GK	65 (4.5)	130 (54)	A4-MGH-R	.0055 - 55.5	.0210 - 210	.3500 - 3500
Tygothane	GKK	65 (4.5)	130 (54)	A4-MGH-R	.0100 - 100.0	.0378 - 378	.6300 - 6300

[illegible]

	M-3 Series		M-4 Series	
Dim	Inches	cm	Inches	cm
A	10-3/4"	27.3	14-1/4"	36.1
B	8-1/8"	20.6	12-1/8"	30.8
C	15-1/4"	38.9	18-5/8"	47.3
D	10"	25.4	11"	27.9
E	12-1/4"	31.0	13-5/8"	34.6
F	4-1/4"	10.7	6"	15.2

M	Flex-Pro® ProSeries-M® Model Number									
Maximum Output Range										
3	Flex-Pro M-3 maximum output 33.3 GPH(126 LPH)									
4	Flex-Pro M-4 maximum output 158.5 GPH (600 LPH)									
Maximum Motor Speed										
2	125 RPM (maximum rotor rotation speed)									
Power Cord (operating voltage requirement 96VAC to 264VAC)										
4	115V / 60Hz, power cord NEMA 5/15 plug (US)									
5	230V / 60Hz, power cord NEMA 6/15 plug (US)									
6	220V / 50HZ, power cord CEE 7/VI plug (EU)									
8	240V / 50HZ, power cord AS 3112 plug (Australia/New zealand)									
X	No Power Cord									
Inlet/Outlet Connection Size, Connection Type, Connection Material										
S	3/8" OD x 1/4" ID Tube Compression Fitting, Natural PVDF (Kynar), available for M-3 models only									
M	1/2" Male NPT Fitting, Natural PVDF (Kynar), available for M-3 and M-4 models									
B	1/2" ID Tubing Barb Fitting, Natural PVDF (Kynar), available for M-4 models only									
C	1/2" - 3/4" Tri-clamp connections, Natural PVDF (Kynar), available for M-3 Flex-A-Prene® models only									
Q	Quick Disconnect, Natural PVDF (Kynar), available on M-3 models only, Flex-A-Prene® only, (Valves sold separately)									
Pump Tube Material, Pump Tube Size										
	ND	Norprene® .075 ID, M-3 models only				THH	Norprene®Chemical .250 ID (Dual Tube), M-4 models only			
	NH	Norprene®.250 ID - M-4 models only				TK	Norprene®Chemical .375 ID			
	NHL	Norprene®.250 ID (65 PSI max pressure - longer life) M-4 only				TKK	Norprene®Chemical .375 ID (Dual Tube), M-4 models only			
	NHH	Norprene®.250 ID (Dual Tube), M-4 models only				GE	Tygothane®.125 ID, M-3 models only			
	NJ	Norprene®.312 ID				GG	Tygothane®.187 ID, M-3 models only			
	NK	Norprene®.375 ID				GH	Tygothane®.250 ID			
	NKL	Norprene®.375 ID (30 PSI max pressure - longer life)				GHH	Tygothane®.250 ID (Dual Tube), M-4 models only			
	NKKL	Norprene®.375 ID (30 PSI max - Dual Tube), M-4 models only				GK	Tygothane®.375 ID			
	NL	Norprene®.500 ID, M-4 models only				GKK	Tygothane®.375 ID (Dual Tube), M-4 models only			
	NP	Norprene®.750 ID, M-4 models only				NEE	Flex-A-Prene®.093 ID (Dual Tube), M-3 models only			
	TH	Norprene®Chemical .250 ID				NGG	Flex-A-Prene®.187 ID (Dual Tube), M-3 models only			
	R	Right facing pump head, input / output (Left facing fluid input / output is standard)								
	D	Down facing pump head, input / output (Left facing fluid input / output is standard)								
M	-	4	2	4	-	M	N	H	Sample Model Number	

Features list:

Features
TFD (Tube Failure Detection) System Alarm
FVS (Flow Verification System) Alarm - Requires Micro-Flo Sensor (sold separately)
10,000:1 turndown reversible motor.
Three position pump head rotation
Tube Life revolution counter with user programmable alarm set-point.
Set maximum motor RPM limit.
Power interruption re-start options.
Four output contacts can be triggered by the status of the TFD system, FVS system, general alarm, rotor direction, motor run/stop, revolution count, motor fail, remote/local setting, input signal failure, output signal failure, and currently active operating mode.
Output: One, 6 amp alarm relay
Output: Three, dry contact or maximum 30VDC/115VAC 1 amp contact closures
Output: Programmable 4-20mA signal or high speed pulse, proportional to pump output
Input: One, contact closure (remote start / stop)
Input: Remote speed control via 4-20mA, 0-10VDC, high speed digital pulse, contact closure pulse
Remote/Local control settings
Password protection
Display: Motor speed, Tube life revolutions, Tube Failure Detection (TFD) system and Flow Verification System (FVS) alarm status
Display: Output in ml/min, oz/min, L/hr, Gal/hr, Gal/day, RPM, and input signal values
Automated PPM chemical dosing system
Available Operating Modes:
Manual (local): speed adjustment
Remote input: 4-20mA
Remote input: 0-10 VDC
Remote input: high speed frequency (pulse) input
Remote input: pulse triggered batch dispensing
Remote input: proportional PPM (parts per million) dosing with high speed frequency (pulse) input
Manual (local): batch dispensing
Manual (local): repeating cycle timer
Manual (local): fixed speed PPM (parts per million) dosing

* Requires Micro-Flo Sensor sold separately

Factory Authorized Representative:



ProSeries-M®
by Blue-White Ind.

5300 Business Drive, Huntington Beach, CA 92649
Tel: 714-893-8529 Fax: 714-894-9492
www.ProSeries-M.com Email: sales@blue-white.com

Patents: 4,496,295, 7,001,153, 8,418,364 and other patents pending

BPE BURT | PROCESS
EQUIPMENT

CHEMPLUS

Chemical Feed System



Reliable, Compact Systems with Complete Flexibility in Customization and Design

100 Overlook Drive Hamden CT 06514
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Fax: (203) 288-7354
Email: customerservice@burtprocess.com
www.burtprocess.com



Founded in 1970, Burt Process Equipment is a worldwide leader in design, manufacturing and distribution of fluid handling equipment, systems and services. BPE products and services provide proven solutions for a multitude industries. Burt Process Equipment is a one-stop, dependable source specializing in prompt delivery from the most comprehensive inventory of fluid handling equipment. Our services include complete engineered system design, turnkey system fabrication, field service and on-site technical and sales support.

Applications

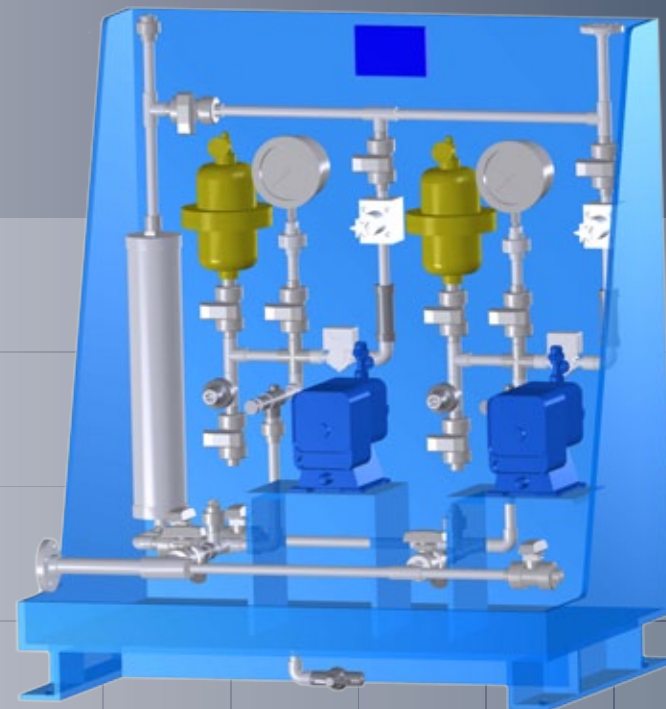
Municipal Water: Disinfection, Sodium Hypochlorite, pH Adjustment, Fluoride, Coagulation & Flocculation

Municipal Wastewater: Fume Scrubbers, pH Adjust, Odor Control, Residual Disinfectant Management

Food & Beverage: Clean-In-Place, Clean-off-Line, Sterilizer Water Treatment

Institutional: Cooling Tower Waste Treatment, Boiler Water Treatment, Closed Loop Systems

Other Applications: in Swimming Pools & Water Parks, Mining & Agriculture, Utilities & Dairy Industry, Pulp & Paper, Oil & Gas



ChemPlus Chemical Metering Systems

The Burt Process **ChemPlus** has revolutionized the concept of chemical dosing systems by providing a fully engineered, pre-packaged, corrosion resistant system that provides **complete flexibility in customization**. ChemPlus gives engineers and systems designers the ultimate in flexibility with the latest advances and widest range of proven technologies. Burt Process draws on over 45 years of experience in specifying and manufacturing chemical processing equipment to provide a feed system design that meets the most rigorous chemical metering demands.

ChemPLUS pre-engineered systems offer a wide range of component options, pump selection and piping arrangements needed to customize chemical metering system solutions.

- Wide range of pump technologies include:
 - Solenoid or Motor Driven Diaphragm Pumps
 - Gear, Peristaltic, Progressing Cavity & more
- Rugged Acid, Caustic & Solvent Resistant Construction
- Complete System Fabrication, Assembly & Test
- Skid & Containment Basin constructed of 1/2" HDPE, Wall or Floor mountable
- Simplex, Duplex, Triplex or Custom Designs
- Piping materials in PP, PVC, CPVC, PVDF, or SS
- Standard & Custom Control Options Available



ChemPlus Simplex System



ChemPlus Duplex System



ChemPlus Triplex System

Standard System Configurations

Simplex w/selectable components

Duplex arrangements include:

- Redundant suction & discharge
- Redundant discharge only
- Lead/Backup, single pipe system

Triplex arrangements include:

- Redundant suction & discharge
- Redundant discharge only

Documented Factory Testing

- ✓ 120-Minute Hydrostatic Pressure Test
- ✓ Pressure Relief Valve Preset & Tested
- ✓ Back Pressure Valve Preset & Tested
- ✓ Pulsation Dampener Charged & Tested
- ✓ Completed Pre-Shipment Check List
- ✓ Documented Inspection Report



Hydrostatic Procedure/Test & Device Setting Report

Customer/Job	
BPE Order	1129914
Equipment	BPE ChemPLUS Sodium Bisulfite Feed Skid, s/n: 1129914A
Test Date	7-10-13

Test Procedure:

1. After fabrication, assembly and cleaning, piping and components shall be pressurized to the test pressure shown below.
2. The following method(s) shall be used:
 - a. Fill equipment with ambient temperature water as the hydraulic medium, vent all air, and pressurize per the chart below. Maintain this test for a minimum of 120 minutes while examining all joints for leaks. Verify and record the pressure at beginning & end of the test.
3. This test shall be considered satisfactory when no leaks or drop in pressure is observed for a minimum of 120 minutes.

General Plumbing	Hydro Test Pressure	Actual Test Pressure
Suction & Discharge Piping PVC	100 psi	_____ psi
Pressure Relief Valve	Pressure Relief Setting	Actual Relief Pressure
1/2" PVC, Adjustable	75 psi	_____ psi
Back Pressure Valve	Pressure Setting	Actual Back Pressure
1/2" PVC, Adjustable	25-30 psi	_____ psi

This is to certify that the above system pipe, fittings, hose, & components have passed hydrostatic testing per the procedure indicated and pressures recorded above.

Pressure Gauge w/Guard
2.5" or 4.5" from 0-160 PSI

Pipe Labeling
Provided with chemical
name & flow direction

Piping
Schedule 80 PVC, CPVC or
Fusion-Welded PVDF

Selectable Pump Options
Pump options include Solenoid,
Mechanical or Hydraulic Diaphragm,
Gear, Peristaltic or Progressing Cavity

ChemPlus Nameplate
(Customized for OEMs)

Back Pressure (anti-syphon) Valve
Two port flow through design & field adjustable
from 15-150 psi

Pulsation Dampener
Removes 99% pulsation, sizes include 4,
10, 36 & 85 cubic inch

Pressure Relief Valve
Two or three port flow through design available
& field adjustable options of 0-75 or 15-150 psi

Calibration Column
Sized for either 30 or 60 second draw down
& available in Clear PVC, PP or Glass

Manual Ball Valves
True union design available vented
or with lockout handles

Visual Flow Indication
Excellent diagnostic tool, Rhythmic rising & falling
of ball indicates positive flow, Flow Indicator upgradable
to flow verification sensors

Single Piece 1/2" HDPE Corrosion Resistant Skid
Wall or Floor mountable w/containment basin
& drain w/valve

Chemical Feed System Model #:

BCPS

SKID CONFIGURATION A SIMPLEX B DUPLEX C DUPLEX DUAL OUTLET D TRIPLEX	CUSTOMIZED FEATURES X NONE S STANDARD OPTIONS* C CUSTOM OPTIONS SC STANDARD AND CUSTOM OPTIONS
PUMP STYLE A AIR OPERATED DIAPHRAGM C PROGRESSING CAVITY D SOLENOID DRIVEN DIAPHRAGM E MOTOR DRIVEN DIAPHRAGM G GEAR H HYDRAULICALLY ACTUATED DIAPHRAGM L PERISTALTIC	PRESSURE GAUGE/GUARD SIZE & RANGE 1 0-30 PSI, 2 1/2" DRY, SS CASE 2 0-60 PSI, 2 1/2" DRY, SS CASE 3 0-100 PSI, 2 1/2" DRY, SS CASE 4 0-160 PSI, 2 1/2" DRY, SS CASE 5 0-30 PSI, 4-1/2" DRY, FULL 316SS CONSTRUCT 6 0-60 PSI, 4-1/2" DRY, FULL 316SS CONSTRUCT 7 0-100 PSI, 4-1/2" DRY, FULL 316SS CONSTRUCT 8 0-160 PSI, 4-1/2" DRY, FULL 316SS CONSTRUCT S SPECIAL
PUMP TUBING/DIAPHRAGM MATERIAL 1 NORPRENE 2 NORPRENE CHEMICAL 3 TYGOTHANE 4 VITON 5 EPDM 6 TEFLON 7 POLYETHYLENE S SPECIAL	BACK PRESSURE VAVE/RANGE 1 15-150 PSI, ADJUSTABLE S SPECIAL X NONE
SINGLE PUMP MAXIMUM FLOW (gph) XXX GALLONS PER HOUR	PRESSURE RELIEF VALVE RANGE 1 5-75 PSI, ADJUSTABLE 2 15-150 PSI, ADJUSTABLE S SPECIAL
PUMP POWER 1 120VAC 2 240VAC, SINGLE PHASE 3 240VAC, THREE PHASE 4 480VAC, THREE PHASE S SPECIAL	PULSATION DAMPENER A 10 CUBIC INCH, THREADED B 36 CUBIC INCH, THREADED C 85 CUBIC INCH, THREADED S SPECIAL X NONE
PIPING/VALVE/COMPONENTS MATERIAL 1 PVC/EPDM/TEFLON 2 PVC/VITON/TEFLON 3 CPVC/VITON/TEFLON 5 PVDF/VITON/TEFLON 6 PVC/VITON/TEFLON (Vented) 7 CPVC/VITON/TEFLON (Vented) S SPECIAL	CALIBRATION CYLINDER/VOLUME A 1.6 GPH (100ml) CLEAR PVC B 4 GPH (250ml) CLEAR PVC C 8 GPH (500ml) CLEAR PVC D 16 GPH (1000ml) CLEAR PVC E 32 GPH (2000ml) CLEAR PVC F 64 GPH (4000ml) CLEAR PVC L 8 GPH (500ml) BOROSILICATE GLASS w/ ACRYLIC SHIELD M 16 GPH (1000ml) BOROSILICATE GLASS w/ ACRYLIC SHIELD S SPECIAL X NONE
PIPING & VALVE SIZE A 1/2" (12 mm) B 3/4" (19 mm) C 1" (25 mm) E 1-1/2" (38 mm) S SPECIAL	FLOW VERIFICATION SENSOR A DIGITAL PADDLEWHEEL, 30 - 300 ml/Min B DIGITAL PADDLEWHEEL, 100 - 1,000 ml/Min C DIGITAL PADDLEWHEEL, 200 - 2,000 ml/Min D DIGITAL PADDLEWHEEL, 500 - 5,000 ml/Min E DIGITAL PADDLEWHEEL, 700 - 7,000 ml/Min S SPECIAL X NONE

*STANDARD OPTIONS
LOCKING VALVES
JUNCTION PANEL
SPARE PARTS PACKAGE



Duplex Unit w/ Splash Guard

System Options

- Flow or Pressure Verification Sensors
- Conduit Box for Power & Control Signals
- Splash Guard Covers
- ChemPlus Nameplate – may be customized
- HDPE or FRP Outdoor Shelters
- Elevated Support Legs or Stand
- Custom Controls & Instrumentation

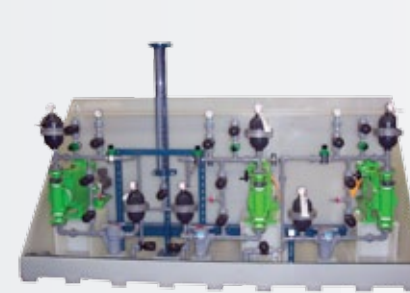


Simplex Unit

Custom Systems

Choose from a variety of standard ChemPlus Systems, or the Burt Process team of highly qualified design engineers can develop a system to meet your specific application needs.

All systems are assembled at our facility on fabricated skids with electrical connections and controls as required.



Control Panels

Burt Process Equipment provides complete industrial control panel design and UL 508A fabrication services as part of our product offering. Burt Process control panels provide the highest quality in workmanship coupled with optimum control in standard and custom enclosures. Interface modules available for Modbus, GENIBus, BACnet, Profibus, PROFINET, GSM/GPRS (wireless communication). All panels are UL 508A listed.

Control Panel Options

- UL Type 4X FRP or stainless steel enclosures for corrosive environments
- Microprocessor based controllers
- Explosion proof rated panels for hazardous environments
- PLC (Programmable Logic Controller) and HMI (Human Machine Interface)
- PC Interface and data acquisition systems



Burt Process also manufactures these reliable, pre-engineered systems



PolymerPlus



RainEx



pHPlus



TransferPlus



CHEMPLUS

Chemical Feed System

Burt Process is a proud Distributor of:

Pumps

AMT	Milton Roy
Ansimag	Netzsch
ARO	Neptune
Barnant	Oberdorfer
Blacoh	Price
Blue-White	Pulsafeeder
Ebara	Pulsatron
Eastern	Sundyne
ECO	Webster

Eclipse
Gorman Rupp
Finish Thompson
Fluid-o-Tech
Flux
Grundfos
Hayward
Ismatec
Isochem
Liberty
Lutz
LMI
March
Masterflex
Magnetex
Micropump

Instrumentation & Controls

Blue White
Dwyer
Flowline
GF
Signet

Valves & Fittings

Asahi
GF Valves
Hayward
Plastomatic
Simtech

Hose & Fittings

Barnant
Colder
Flex Tubing
Masterflex
Nalgene

Tanks & Mixers

Chemtainer
Cleveland Eastern
Fusion Fluid
Nalgene
Norwesco
Peabody

Motors & Drives

ABB
AC Tech
Baldor
Emotron
Siemens
Weg



Corporate Headquarters

100 Overlook Drive
Hamden, CT 06514
T: (203) 287-1985
F: (203) 288-7354

Sales Locations

California

T: (877) 742-2878
F: (877) 742-2231

New England

T: (978) 649-9660
F: (978) 649-7430

New York

T: (518) 477-5005
F: (518) 477-5008

Connecticut

T: (203) 287-1985
F: (203) 288-7354

Mid-Atlantic

T: (717) 792-6950
F: (717) 792-6953

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SUBMITTAL CALCULATIONS

Project:	Brandenburg Facilities Plan		
Owner:	City of Brandenburg		
GRW Project No.:	4556		
Date:	April 24, 2017	Cal. By:	NWG
Desc.:	Contact Time for PAA Pilot		

Known Values:

Design Average Flow: 0.312 MGD

Design Peak Flow: 0.932 MGD

Average Historic Effluent Flow (2016): 0.181 MGD

Pipe Diameter: 15-inch PVC

Approx. Length from Dechlorination Induction Station and Existing Manhole: 2,000 LF

Slope: 0.002 ft/ft (from Record Drawings)

n: 0.009

Full Pipe Flow Calculations:

$$A = \pi(0.625)^2 = 1.227 \text{ ft}^2$$

$$WP = 2\pi(0.625) = 3.927 \text{ ft}$$

$$R = \frac{A}{WP} = \frac{1.227}{3.927} = 0.3125 \text{ ft}$$

$$Q_{full} = \left(\frac{1.49}{n}\right)(A)(R^{2/3})(\sqrt{S}) = \left(\frac{1.49}{0.009}\right)(1.227)(0.3125^{2/3})(\sqrt{0.002}) = 4.18 \text{ ft}^3/\text{sec} \approx 2.7 \text{ MGD}$$

$$V_{full} = \left(\frac{4.18}{\pi(0.625^2)}\right) = 3.41 \text{ ft}/\text{sec}$$

Average Influent Design Flow Contact Time:

$$\frac{Q}{Q_{full}} = 0.12 \rightarrow \frac{V}{V_{full}} \approx 0.66 \rightarrow V = 2.25 \text{ ft}/\text{sec} \text{ (Using circular channel ratios graph)}$$

$$t_d = \frac{2000}{2.25} = 888.89 \text{ sec} = 14.8 \text{ min.}$$

Peak Influent Design Flow Contact Time:

$$\frac{Q}{Q_{full}} = 0.35 \rightarrow \frac{V}{V_{full}} \approx 0.92 \rightarrow V = 3.14 \text{ ft}/\text{sec} \text{ (Using circular channel ratios graph)}$$

$$t_d = \frac{2000}{3.14} = 636.94 \text{ sec} = 10.6 \text{ min.}$$

Average Historic Effluent Flow Contact Time:

$$\frac{Q}{Q_{full}} = 0.07 \rightarrow \frac{V}{V_{full}} \approx 0.58 \rightarrow V = 1.98 \text{ ft}/\text{sec} \text{ (Using circular channel ratios graph)}$$

$$t_d = \frac{2000}{1.98} = 1011.22 \text{ sec} = 16.9 \text{ min.}$$

Appendix G

Existing Rates and Charges

City of Brandenburg

737 High Street

P.O. Box 305

Brandenburg, KY 40108

(270)422-4981

Fax: (270)422-4983

Office Hours: Monday-Friday

8:00am-4:30pm

Afterhours Water/Sewer

Emergency:

(270)422-3774

Like us on



@ Brandenburg City Hall for
announcements and updates!

*Garbage Pick-up in the City Limits
is on Tuesday and Friday weekly.

*Recycle in the City Limits is on
Tuesday only.

*All water bills are due on the 15th
of each month, penalties will be
applied on the 16th, and shutoffs
will be done on the 26th of each
month.

*Water meters are read monthly to
determine usage, the sewer portion
of your bill is based on the amount
of water consumption per month.

Inside City Limits

Current Water Rates

First 2000 Gals./Month or less = \$11.68
next 3000 Gals./Month per 1000 = \$3.36
next 5000 Gals./Month per 1000 = \$3.11
next 20,000 Gals./Month per 1000 = \$2.71
next 15,000 Gals./Month per 1000 = \$2.24
over 45,000 Gals./Month per 1000 = \$1.87

Current Sewer Rates

First 2000 Gals./Month or less = \$15.11
next 3000 Gals./Month per 1000 = \$5.54
next 5000 Gals./Month per 1000 = \$5.33
next 20,000 Gals./Month per 1000 = \$5.05
next 15,000 Gals./Month per 1000 = \$4.64
over 45,000 Gals./Month per 1000 = \$4.34

Outside City Limits

Current Water Rates

First 2000 Gals./Month or less = \$18.01
next 3000 Gals./Month per 1000 = \$5.20
next 5000 Gals./Month per 1000 = \$4.77
next 20,000 Gals./Month per 1000 = \$4.20
next 15,000 Gals./Month per 1000 = \$3.47
over 45,000 Gals./Month per 1000 = \$2.89

Current Sewer Rates

First 2000 Gals./Month or less = \$16.07
next 3000 Gals./Month per 1000 = \$5.83
next 5000 Gals./Month per 1000 = \$5.54
next 20,000 Gals./Month per 1000 = \$5.25
next 15,000 Gals./Month per 1000 = \$4.85
over 45,000 Gals./Month per 1000 = \$4.50

Appendix H

Crosscutter Correspondence

U.S. Fish and Wildlife Service

KY Department of Fish and Wildlife

Kentucky Heritage Council

U.S. Natural Resources Conservation Service

U.S. Army Corps of Engineers

City of Brandenburg

737 HIGH STREET POST OFFICE BOX 305 BRANDENBURG, KENTUCKY 40108 PHONE 270-422-4981 FAX 270-422-4983

October 27, 2017

Mr. Russell Neal
Environmental Control Supervisor
Wastewater Municipal Planning &
Capacity Development Section
Water Infrastructure Branch
Division of Water
300 Sower Boulevard
Frankfort, KY 40601

Re: City of Brandenburg
Wastewater Facilities Plan
Cross-Cutter Review and Approval
GRW Project No. 4556

MAYOR
Ronnie Joyner

CITY COUNCIL
Bruce Fackler
Chris Hulsey
Bryan Claycomb
Patsy Lusk
Maggie Love
Scotty Applegate

CLERK/TREASURER
Amy Haynes

POLICE CHIEF
Scotty Singleton
PUBLIC WORKS
DIRECTOR
Timothy J. Hughes, Jr.

Dear Mr. Neal:

GRW has explained your comments concerning the Cross-Cutter correspondence included in the Facilities Plan. The general request for review of proposed projects in the 20-year planning area have been submitted, and the responses stating that each project will need to be submitted when more detailed information is available.

We interpret these comments from the Cross-Cutters to mean that we should submit our projects when design is well underway, and decisions concerning processes and location of facilities are more concrete and detailed. We will certainly follow these guidelines to submit to each of the agencies when we are at an appropriate benchmark in the design phase.

Please feel free to contact me or Joe Pavoni at GRW if you have any other questions or comments.

Sincerely,



Ronnie Joyner
Mayor, City of Brandenburg

Cc: Joseph V. Pavoni, PE, LEED AP, GRW

"A City of Progress"



GRW | engineering | architecture | geospatial
9710 Bunsen Parkway | Louisville, KY 40299
502.489.8484 | www.grwinc.com

September 22, 2017

Mr. Lee Andrews
Field Supervisor
U.S. Department of Interior
Fish and Wildlife Service
J.C. Watts Federal Building
330 West Broadway, Suite 265
Frankfort, KY 40601

**Re: Cross-Cutter Correspondence
Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556**

Dear Mr. Andrews:

On behalf of the City of Brandenburg, GRW is preparing a Wastewater Facilities plan pursuant to the regulations of the Kentucky Division of Water, as required by 401 KAR 5:006. The purpose of this plan is to develop recommendations for a series of projects that will be constructed to improve wastewater collection and treatment in the City's Planning Area of the Planning Period of 2017 to 2037. Exhibit 2-6 illustrates the Planning Area Boundary and planning phases. Exhibit 5-1 illustrates the existing wastewater collection system.

The Facilities Plan includes a series of projects that will be completed over the next 20 years in phases. Some of these projects will be built within the wastewater collection system or at the treatment plant site.

The collection system projects include new gravity sewers, new lift stations and force mains, constructed in easements or along existing road right-of-way in order to sewer existing neighborhoods (see Exhibit 1-4). These collection system projects are expected to be completed within the 3-10 and 11-20 year planning phases. The City may or may not choose to construct the collection system projects.

The treatment plant project (see Exhibit 6-3.1), expected to be completed by December 31, 2021, includes concrete treatment structures, buried pipes, rehabilitation of existing structures, and the abandonment and/or demolition of some existing plant components that are no longer required for treatment. The treatment plant project will be on the existing plant site that was disturbed by the original construction of the plant in 1993. The discharge of treated wastewater will remain at its existing location, which is on the Ohio River at mile point 643.3, segment 08217. The average daily discharge rate is projected to increase from its current flow rate of approximately 0.232 MGD (million gallons per day) to 0.268 MGD by 2037. The existing WWTP, however, is already rated to treat 0.312 MGD.

We would appreciate your advice of any concerns your office may have related to possible adverse effects of these projects as soon as possible. We need to incorporate your response in the Facilities Plan, and also address your concerns regarding any potential adverse impacts of these projects.

It is anticipated that these projects will be funded by a series of grants and loans, such as the USDA Rural Development Agency Grant and Loan Program and the Kentucky Infrastructure Agency State Revolving Fund Loan Program.

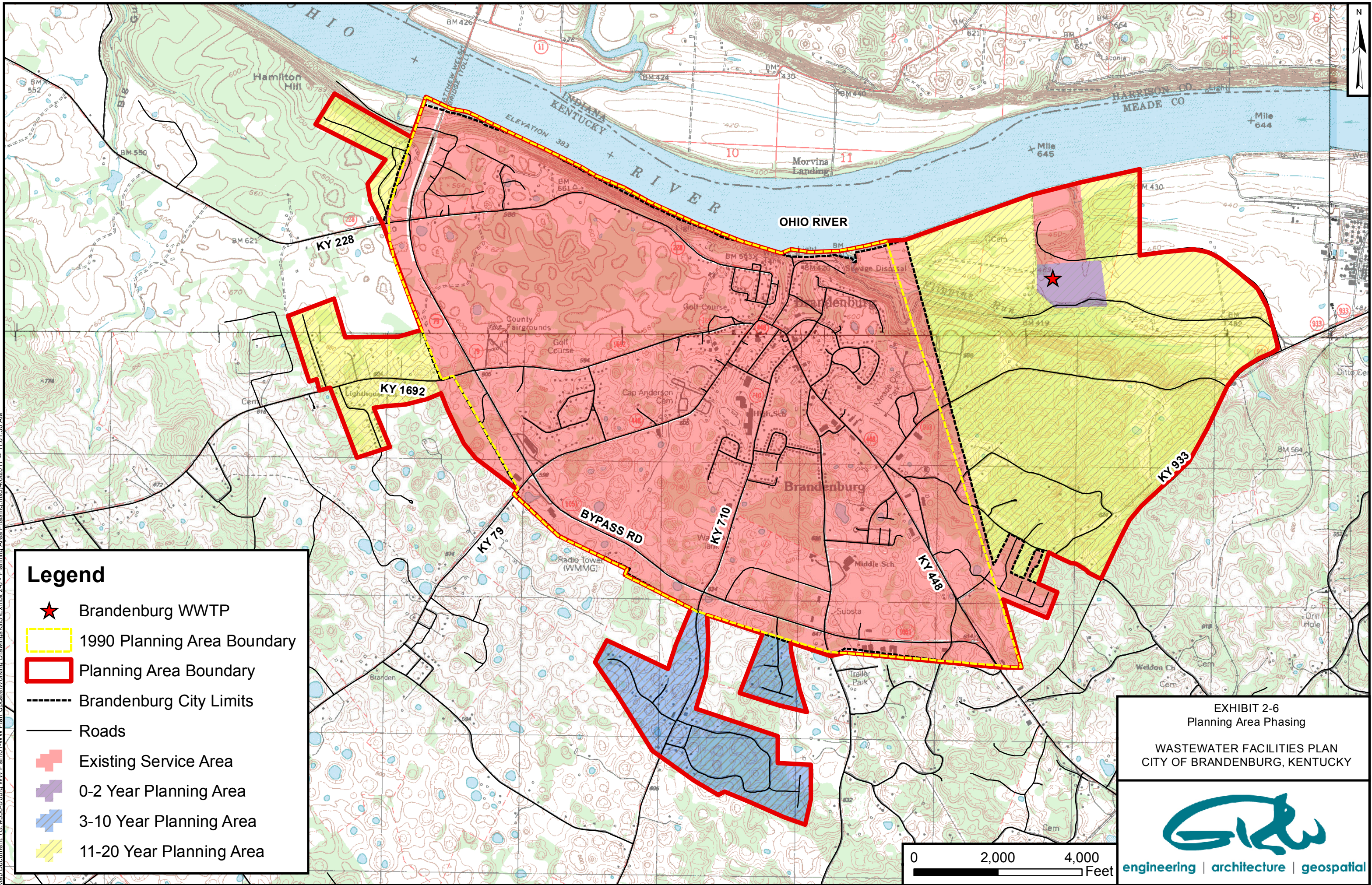
Please feel free to contact me if you have any questions or comments. I may be reached at 502-489-8484 or at ngunselman@grwinc.com

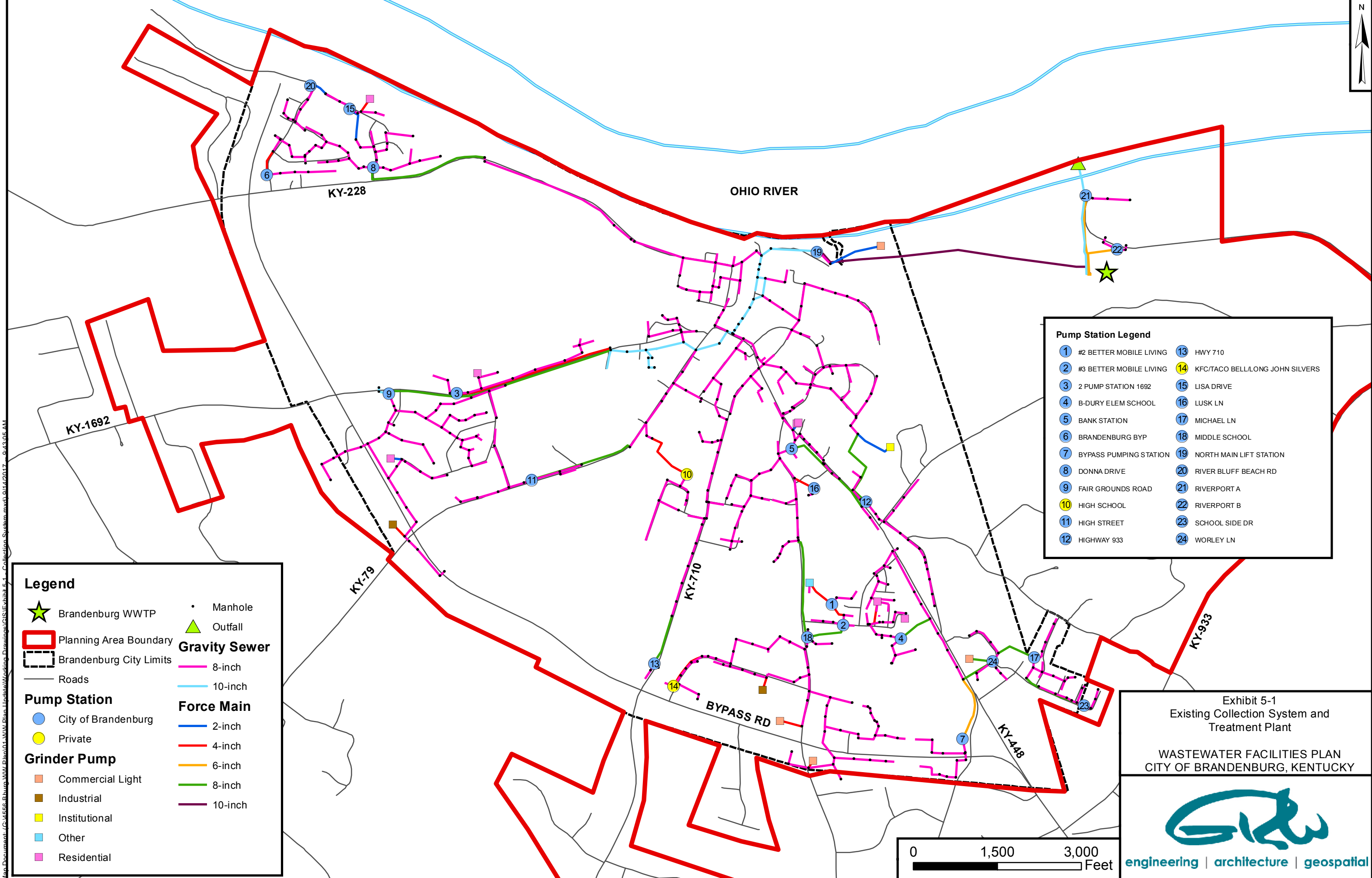
Sincerely,

Nicholas Gunselman, P.E.
Project Engineer

Enclosures (4)

Map Document: G:\4558-Ebura WW Plan Update\Working Drawings\GIS\Exhibit 2-6 - Planning Area Phasing.mxd 4/6/2017 -- 11:01:50 AM





Map Document: C:\M558-Burg\MM\Plan\01_MMM_Plan_Hostal\Working Drawings\GIS\Exhibit 5-1 - Collection System.mxd 9/14/2017 9:43:05 AM

Legend

- Brandenburg WWTP

Planning Area Boundary

Brandenburg City Limits

Roads

Pump Station

City of Brandenburg

Private

Grinder Pump

Commercial Light

Industrial

Institutional

Other

Residential
- Manhole

Outfall

Gravity Sewer

8-inch

10-inch

Force Main

2-inch

4-inch

6-inch

8-inch

10-inch

Pump Station Legend

- | | |
|-------------------------|---------------------------------|
| #2 BETTER MOBILE LIVING | HWY 710 |
| #3 BETTER MOBILE LIVING | KFC/TACO BELL/LONG JOHN SILVERS |
| 2 PUMP STATION 1692 | LISA DRIVE |
| B-DURY ELEM SCHOOL | LUSK LN |
| BANK STATION | MICHAEL LN |
| BRANDENBURG BYP | MIDDLE SCHOOL |
| BYPASS PUMPING STATION | NORTH MAIN LIFT STATION |
| DONNA DRIVE | RIVER BLUFF BEACH RD |
| FAIR GROUNDS ROAD | RIVERPORT A |
| HIGH SCHOOL | RIVERPORT B |
| HIGH STREET | SCHOOL SIDE DR |
| HIGHWAY 933 | WORLEY LN |

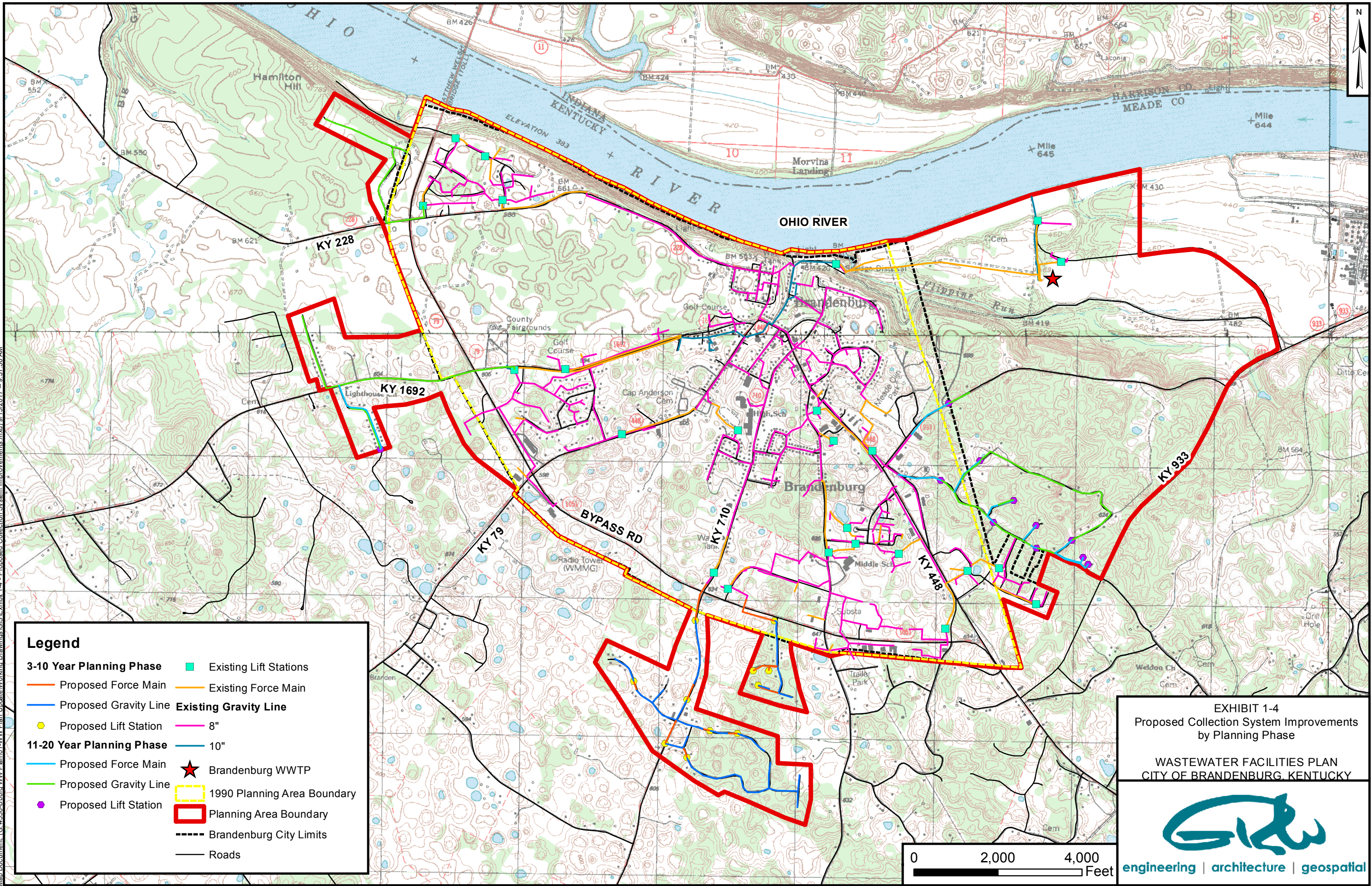
Exhibit 5-1
Existing Collection System and
Treatment Plant

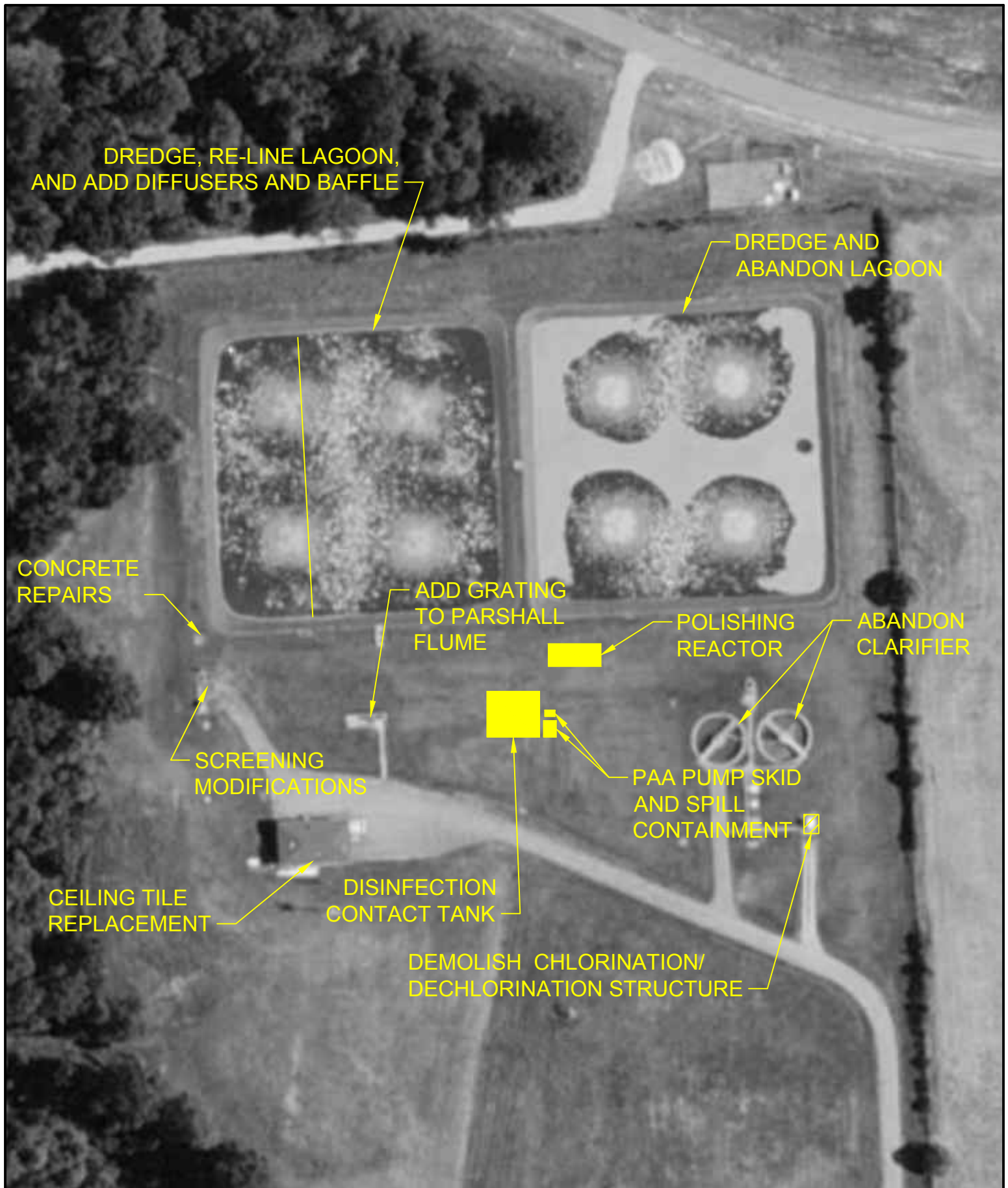
WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY



engineering | architecture | geospatial

Map Document: G:\4556-Elburg WW Plan\Update\Working Drawings\GIS\Exhibit 1-4 - Proposed Collection System Improvements.mxd 9/13/2017 - 9:37:56 AM





GRW PROJECT NO. 4566-01

DIFFUSERS & POLISHING REACTOR ALTERNATIVE 3

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY



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www.grwinc.com

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NOT BE REPRODUCED IN WHOLE OR IN PART OR USED FOR CONSTRUCTION
OF OTHER THAN THIS SPECIFIC PROJECT WITHOUT WRITTEN PERMISSION

DATE:
SEPT., 2017

SCALE:
1" = 100'

SHEET NO.
EXHIBIT
6-3.1



GRW | engineering | architecture | geospatial
9710 Bunsen Parkway | Louisville, KY 40299
502.489.8484 | www.grwinc.com

September 22, 2017

Mr. Steve Beam
Wildlife Director
Kentucky Department of
Fish and Wildlife Resources
#1 Sportsman's Lane
Frankfort, KY 40601

**Re: Cross-Cutter Correspondence
Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556**

Dear Mr. Beam:

On behalf of the City of Brandenburg, GRW is preparing a Wastewater Facilities plan pursuant to the regulations of the Kentucky Division of Water, as required by 401 KAR 5:006. The purpose of this plan is to develop recommendations for a series of projects that will be constructed to improve wastewater collection and treatment in the City's Planning Area of the Planning Period of 2017 to 2037. Exhibit 2-6 illustrates the Planning Area Boundary and planning phases. Exhibit 5-1 illustrates the existing wastewater collection system.

The Facilities Plan includes a series of projects that will be completed over the next 20 years in phases. Some of these projects will be built within the wastewater collection system or at the treatment plant site.

The collection system projects include new gravity sewers, new lift stations and force mains, constructed in easements or along existing road right-of-way in order to sewer existing neighborhoods (see Exhibit 1-4). These collection system projects are expected to be completed within the 3-10 and 11-20 year planning phases. The City may or may not choose to construct the collection system projects.

The treatment plant project (see Exhibit 6-3.1), expected to be completed by December 31, 2021, includes concrete treatment structures, buried pipes, rehabilitation of existing structures, and the abandonment and/or demolition of some existing plant components that are no longer required for treatment. The treatment plant project will be on the existing plant site that was disturbed by the original construction of the plant in 1993. The discharge of treated wastewater will remain at its existing location, which is on the Ohio River at mile point 643.3, segment 08217. The average daily discharge rate is projected to increase from its current flow rate of approximately 0.232 MGD (million gallons per day) to 0.268 MGD by 2037. The existing WWTP, however, is already rated to treat 0.312 MGD.

We would appreciate your advice of any concerns your office may have related to possible adverse effects of these projects as soon as possible. We need to incorporate your response in the Facilities Plan, and also address your concerns regarding any potential adverse impacts of these projects.

It is anticipated that these projects will be funded by a series of grants and loans, such as the USDA Rural Development Agency Grant and Loan Program and the Kentucky Infrastructure Agency State Revolving Fund Loan Program.

Please feel free to contact me if you have any questions or comments. I may be reached at 502-489-8484 or at ngunselman@grwinc.com

Sincerely,

Nicholas Gunselman, P.E.
Project Engineer

Enclosures (4)



GRW | engineering | architecture | geospatial
9710 Bunsen Parkway | Louisville, KY 40299
502.489.8484 | www.grwinc.com

September 22, 2017

Mr. Craig Potts
Executive Director and
State Preservation Officer
Kentucky Heritage Council
410 High Street
Frankfort, KY 40601

**Re: Cross-Cutter Correspondence
Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556**

Dear Mr. Potts:

On behalf of the City of Brandenburg, GRW is preparing a Wastewater Facilities plan pursuant to the regulations of the Kentucky Division of Water, as required by 401 KAR 5:006. The purpose of this plan is to develop recommendations for a series of projects that will be constructed to improve wastewater collection and treatment in the City's Planning Area of the Planning Period of 2017 to 2037. Exhibit 2-6 illustrates the Planning Area Boundary and planning phases. Exhibit 5-1 illustrates the existing wastewater collection system.

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September 22, 2017

Ms. Ruth S. Pike
Acting Supervisory Natural Resource Manager
USDA Natural Resources Conservation Services
Hardinsburg Service Center
1101 S. Highway 261
Hardinsburg, KY 40143

**Re: Cross-Cutter Correspondence
Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556**

Dear Ms. Pike:

On behalf of the City of Brandenburg, GRW is preparing a Wastewater Facilities plan pursuant to the regulations of the Kentucky Division of Water, as required by 401 KAR 5:006. The purpose of this plan is to develop recommendations for a series of projects that will be constructed to improve wastewater collection and treatment in the City's Planning Area of the Planning Period of 2017 to 2037. Exhibit 2-6 illustrates the Planning Area Boundary and planning phases. Exhibit 5-1 illustrates the existing wastewater collection system.

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September 22, 2017

Ms. Pam J. Loeffler
Regulatory Specialist
U.S. Army Corps of Engineers
Louisville District
P.O. Box 59
Louisville, KY 40201

**Re: Cross-Cutter Correspondence
Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556**

Dear Ms. Loeffler:

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Sincerely,

Nicholas Gunselman, P.E.
Project Engineer

Enclosures (4)

Appendix I

City and County Resolutions

Appendix J

**Public Meeting Minutes,
Public Meeting Presentation,
Attendance Roster,
Public Comments,
Affidavit of Publication,
and The Meade County
Messenger & Times Tear Sheets**

Appendix K

Design Calculations

I. OVERVIEW

A Lemna Environmental Technologies, Inc. Biological Treatment Process (BTP) can include various unit processes to achieve project-specific treatment goals. Lagoon unit processes include Complete Mix (CM), followed by Settling Cell. The Lemna Polishing Reactor (LPR) is a post-lagoon reactor designed for polishing lagoon effluent. The performance of each unit process is modeled using calculations formulated from published references and supported by field experience. The purpose of this document is to provide a summary of the theoretical basis for each calculation.

II. ORGANICS REMOVAL

A. Complete Mix – Mechanistic Approach

The removal of organics in the CM cell is calculated using a “mechanistic” model that relates the growth of heterotrophic bacteria to the removal of carbonaceous biochemical oxygen demand (CBOD₅). The equations for determination of effluent concentration of CBOD₅ for a complete mix cell are provided below (Rich, 1999):

$$S_e = \frac{K_s(1 + k_d \times DT)}{DT(\mu_m - k_d) - 1}$$

Where:

S_e = Effluent CBOD₅, mg/L

k_d = Bacterial Decay Rate, d⁻¹

DT = Detention Time, d

K_s = Half-Saturation Constant = 120 mg/L (default value),

μ_m = Maximum Heterotrophic Specific Growth Rate, d⁻¹

Maximum heterotrophic growth rate is adjusted for temperature using the following equations:

$$\mu_m = \mu_{m20} \times 1.026^{T-20} \text{ (for } T \text{ between } 10^\circ\text{C and } 30^\circ\text{C)}$$

$$\mu_m = 0.774 \times \mu_{m20} \times 1.058^{T-20} \text{ (for } T \text{ between } 2^\circ\text{C and } 10^\circ\text{C)}$$

Where:

μ_{m20} = 6.0 d⁻¹ (Grady and Daigger, 1999)

T = Wastewater Temperature, °C

The following equations are used to calculate bacterial decay rate:

$$k_{d20} = 0.48 \times DT^{-0.415}$$

$$k_d = k_{d20} \times 1.05^{T-20}$$

For summer, complete mix cell 1A, $T=20^\circ\text{C}$

$$\mu_m = 6.0 \times 1.026^{20-20} = 6.0 \text{ d}^{-1}$$

$$k_{d20} = 0.48 \times 3.0^{-0.415} = 0.30 \text{ d}^{-1}$$

$$k_d = 0.30 \times 1.05^{20-20} = 0.30 \text{ d}^{-1}$$

BOD summer effluent from the complete mix cell, 1A

$$S_e = \frac{120(1 + 0.30 \times 3.0)}{3.0(6.0 - 0.30) - 1} = 14 \text{ mg/L}$$

For winter, complete mix cell 1A, $T=8.2^\circ\text{C}$

$$\mu_m = 0.774 \times 6.0 \times 1.058^{8.2-20} = 4.2 \text{ d}^{-1}$$

$$k_{d20} = 0.48 \times 3.0^{-0.415} = 0.30 \text{ d}^{-1}$$

$$k_d = 0.30 \times 1.05^{8.2-20} = 0.17 \text{ d}^{-1}$$

BOD winter effluent from the complete mix cell, 1A

$$S_e = \frac{120(1 + 0.17 \times 3.0)}{3.0(4.2 - 0.17) - 1} = 16 \text{ mg/L}$$

III. AMMONIA REMOVAL

A. Complete Mix - Nitrification

The removal of ammonia in the CM cell in the summer that can be attributed to nitrifying bacteria is calculated using an equation that relates the removal of ammonia to the bacterial growth rate. The equations are provided below (Rich, 1999):

$$N = \frac{K_N}{DT \times \left(\mu_m \frac{O_2}{K_{O_2} + O_2} [1 - 0.83(7.2 - \text{pH})] \right) - 1}$$

Where:

N = Effluent Ammonia, mg/L

μ_m = Maximum Nitrifier Specific Growth Rate, d^{-1}

O_2 = Dissolved Oxygen, mg/L

pH = Hydrogen Ion Concentration

K_N = Half-Saturation Constant for Ammonium Nitrogen, mg/L

K_{O_2} = Half-Saturation Constant for Dissolved Oxygen = 1.2 mg/L

DT = Detention Time, d

K_N and μ_m are adjusted for temperature using the following equation:

$$\mu_m = 10^{0.0413T - 0.944}$$

and

$$K_N = 10^{0.051T - 1.158}$$

Where:

T = Wastewater Temperature, $^{\circ}\text{C}$

For summer complete mix cell 1A, $T=20^{\circ}\text{C}$

$$\mu_m = 10^{0.0413 \times 20 - 0.944} = 0.767 \text{ d}^{-1}$$

$$K_N = 10^{0.051 \times 20 - 1.158} = 0.728 \text{ d}^{-1}$$

NH_3 summer effluent from the complete mix cell 1 A

$$N = \frac{0.728}{3.0 \times \left(0.767 \frac{2}{1.2 + 2} [1 - 0.83(7.2 - 7.2)] \right) - 1} = 1.7 \text{ mg/L}$$

B. Complete Mix – Heterotrophic Uptake

Removal of ammonia in CM cell in winter is partially accounted for by the uptake of nitrogen by heterotrophic bacteria to meet stoichiometric demands for cell synthesis. The ammonia used for synthesis of heterotrophic organisms is calculated using following equation (Grady and Daigger, 1999):

$$N_R = \Delta \text{CBOD}_5 \times Y \times 0.087$$

Where:

N_R = Heterotrophic Nitrogen Requirements, mg/L

ΔCBOD_5 = CBOD_5 Removed, mg/L

Y = Bacterial Yield, mg biomass-COD/mg CBOD

0.087 = Nitrogen Content of Biomass, mg-N/mg-biomass-COD

$$N_R = 385 \times 0.5 \times 0.087 = 16.7 \text{ mg/L}$$

NH_3 winter effluent from the complete mix cell 1 A

$$N = 27.0 - 16.7 = 10.3 \text{ mg/L}$$

C. Lemna Polishing Reactor - Nitrification

LPR media requirements for ammonia removal are calculated according to the following equation:

$$A = \frac{\Delta \text{NH}_3 \times Q \times 8.34}{G_T}$$

Where:

A = Media Surface Area, ft^2

ΔNH_3 = Ammonia Removed, mg/L

Q = Flow, MGD

G_T = NH_3 removal rate, $\text{lb NH}_3/\text{ft}^2\text{-media/day}$

LPR ammonia removal rate, G_{20} at 20 degrees Celsius, is 0.0003 $\text{lbs}/\text{ft}^2\text{-media/day}$. The removal rate is adjusted for wastewater temperature using the following equation:

$$G_T = G_{20} (1.072)^{T-20}$$

Where:

G_{20} = reaction rate at 20°C

T = design wastewater temperature, °C

For influent wastewater temperature of 3.2°C

$$G_T = 0.0003(1.072)^{3.2-20} = 0.00009 \text{ lbs/ft}^2/\text{day}$$

For the influent ammonia concentration to the LPR of 27 mg-N/L assuming none ammonia removal in the lagoon;

$$A = \frac{(27 - 20) \times 0.312 \times 8.34}{0.00009} = 195890 \text{ ft}^2$$

For media cubes of 6' x 6' x 10' at 68 ft²/ft³ density

NH₃ cubes required = 8 cubes

Total modules provided = 10 cubes

IV. OXYGEN REQUIREMENT

D. Complete Mix and LPR

The first step in the calculation of aeration requirements is the determination of the mass load (CBOD₅ and NH₃) removed under worst-case conditions. The mass load, L, is calculated by multiplying the flow and concentration and correcting for units.

$$L_{\text{CBOD}_5} = Q \times \Delta \text{CBOD}_5 \times 8.34$$

$$L_{\text{NH}_3} = Q \times \Delta \text{NH}_3 \times 8.34$$

Where:

L_{CBOD_5} = CBOD₅ Removed, lb-CBOD₅ /d

L_{NH_3} = NH₃ Removed, lb-NH₃ /d

ΔCBOD_5 = CBOD₅ Removed, mg-CBOD₅ /L

ΔNH_3 = NH₃ Removed, mg-NH₃ /L

Q = Flow, MGD

Cell #1A: $8.34 \times 0.312 \times (401 - 14) \cong 1006 \text{ lb-CBOD}_5 / \text{d}$
 $8.34 \times 0.312 \times 27 \cong 70 \text{ lb-NH}_3 / \text{d}$

LPR: $8.34 \times 0.312 \times (27-20) = 18 \text{ lb-NH}_3 / \text{d}$

The next step is a calculation of the amount of “actual” oxygen required to support the removal of the calculated load. Factors of 1.0 lb O₂/lb CBOD₅ and 4.6 lb O₂/lb NH₃ are used to account for the bacterial oxygen demands in the CM cell (Note: oxygen demands for bacterial digestion are calculated separately).

$$AOR_{CBOD_5} = 1.0 \times L_{CBOD_5}$$

$$AOR_{NH_3} = 4.6 \times L_{NH_3}$$

Where:

AOR_{CBOD₅} = Actual Oxygen Requirements for CBOD₅ load, lb-O₂ /d

AOR_{NH₃} = Actual Oxygen Requirements for NH₃ load, lb-O₂ /d

1.0 = lb-O₂ required / lb CBOD₅ removed

4.6 = lb-O₂ required / lb NH₃ removed

$$\text{Cell \#1A: } 1,006 \text{ lb CBOD}_5/\text{d} \times 1.0 \text{ lb-O}_2/\text{lb CBOD}_5 + 70 \text{ lb NH}_3/\text{d} \times 4.6 \text{ lb-O}_2/\text{lb NH}_3 = 1328 \text{ lb-O}_2/\text{d}$$

$$\text{LPR: } 18 \text{ lb NH}_3/\text{d} \times 4.6 \text{ lb-O}_2/\text{lb NH}_3 = 83.8 \text{ lb-O}_2/\text{d}$$

The actual oxygen requirements are adjusted to standard conditions using a correction factor. The correction factor accounts for various factors that will affect oxygen transfer from site to site.

$$SOR = \frac{AOR}{CF}$$

Where:

SOR = Standardized Oxygen Requirement, lb-O₂ /d

AOR = Actual Oxygen Requirement, lb-O₂ / d

CF = Correction Factor

The correction factor has the following equation:

$$CF = \alpha \times \left(\frac{(\beta \times C_s \times \delta) - RO}{C_{s20}} \right) \times F \times \Theta_{MT}^{T-20}$$

Summer:

$$CF = 0.75 \times \left(\frac{(0.95 \times 8.9 \times 17.0/14.4) - 2.0}{9.09} \right) \times 0.9 \times 1.024^{20-20} = 0.59$$

Winter:

$$CF = 0.75 \times \left(\frac{(0.95 \times 11.5 \times 17.0/14.4) - 2.0}{9.09} \right) \times 0.9 \times 1.024^{3.2-20} = 0.54$$

Where:

α = Surface Tension Correction Factor = 0.75

β = Solubility Correction Factor = 0.95

C_{S20} = O_2 Saturation at Standard Conditions = 9.09 mg / L

C_S = Oxygen Saturation at Water Surface, mg / L

RO = Residual Oxygen = 2.0 mg / L

Θ_{MT} = Temperature – Mass Transfer Correction Factor = 1.024

T = Design Water Temperature, °C

F = Diffuser Factor = 0.9

$\delta = P_{eff} / P$ = Pressure Correction Factor

P_{eff} = Effective Pressure of Aeration, psia

$$P_{eff} = P + \left(0.433 \times \frac{WD}{2} \right)$$

$$P_{eff} = 14.4 \text{ psi} + (0.433 \times 12/2) = 17.0 \text{ psi}$$

Where:

P = Site Barometric Pressure, psia

WD = Water Depth, ft

0.433 = Conversion Factor, feet to psia

Cell #1A: SOR = 1328/0.59 \cong 2251 lb/d

LPR: SOR = 83.8/0.54 \cong 155 lb/d

The SOR is used in combination with manufacturer supplied aeration efficiencies to compute the required air flow to meet the bacterial oxygen demand. The following equation is used for calculating air flow requirement:

$$Q_{air} = f \times \frac{SOR}{SOTE}$$

Where:

Q_{air} = Air Requirement, SCFM

SOTE = Manufacturer's Transfer Efficiency, %

f = Conversion Factor from lbs- O_2 /day to SCFM

$$\text{Cell \#1A: } Q_{\text{air}} = 4.025 \times \frac{2251 \text{ lb-} O_2 / \text{d}}{17.3\%} = 523 \text{ SCFM}$$

$$\text{LPR: } Q_{\text{air}} = 4.025 \times \frac{155 \text{ lb-} O_2 / \text{d}}{16.1\%} = 38 \text{ SCFM}$$

E. Digestion

Ten State Standards requires 1.5 pounds of oxygen per pound of CBOD₅ removed for aerated lagoons. The 0.5 portion of that factor is required for digestion (benthal stabilization). The sludge, in settling cell, is deposited on the lagoon floor. Over time, the sludge accumulates, compacts, and slowly digests. The amount of oxygen required to support benthal stabilization is calculated by the following equation:

$$AOR_D = 0.5 \times L_{\text{CBOD}_5}$$

Where:

L_{CBOD_5} = CBOD₅ removed, lb-CBOD₅ /d

AOR_D = Actual Oxygen Requirement for Bacterial Digestion, lbs O_2 /d

$$AOR = 1,006 \text{ lb BOD/d} \times 0.5 \text{ lb-} O_2 / \text{lb BOD}_5 = 503 \text{ lb } O_2 / \text{d}$$

$$SOR = 503 / 0.59 \cong 852 \text{ lb/d}$$

$$\text{Cell \#1B: } Q_{\text{air}} = 4.025 \times \frac{852 \text{ lb-} O_2 / \text{d}}{17.3\%} = 198 \text{ SCFM}$$

90% of air flow required for digestion will be supplied in settling cell.

V. Mixing Requirements

F. Blower mixing

For the purpose of sizing aeration to achieve complete mix conditions, a dissipated energy of 13.5 HP/MG is used. This value is multiplied by the complete mix cell volume to determine the power dissipated, P.

$$P_{CM} = 13.5 \text{ HP/MG} \times Q \times DT$$

Where:

P_{CM} = Dissipated Power, HP

Q = Flow, MGD

DT = Detention Time, d

$$P_{CM} = 13.5 \text{ HP/MG} \times 0.312 \text{ MGD} \times 3.0 \text{ d} = 12.6 \text{ HP} = 6930 \text{ ft-lb/s}$$

Given a desired amount of energy dissipation into a volume of water, the following equation is used to determine an equivalent air flow (Metcalf & Eddy, 1991).

$$Q_a = \frac{P_{CM}}{K \times \ln\left(\frac{h + 33.9}{33.9}\right)}$$

Where:

Q_a = Air Flow Rate, CFM

P_{CM} = Power Dissipated, ft-lb/s

K = Constant (35.28, U.S. customary units)

h = Air Pressure at Discharge, ft (water)

$$\text{Cell \#1A: } Q_a = \frac{6930}{35.28 \times \ln\left(\frac{12 + 33.9}{33.9}\right)} = 650 \text{ CFM}$$

VI. Equipment Selection

Equipment selection is based on aeration and/or mixing, whichever requires the highest horsepower.

Cell #1A: 38 diffusers x 18 SCFM = 684 SCFM

Cell #1B: 20 diffusers x 9 SCFM = 180 SCFM

LPR: 90 SCFM

Total air requirement equals:

$$Q_{\text{air}} = 684 \text{ SCFM} + 180 \text{ SCFM} + 90 \text{ SCFM} = 954 \text{ SCFM}$$

The blower power motor requirement is calculated using the following equation:

$$\text{BHP} = \frac{Q_{\text{air}} \times f_2}{E_{\text{blow}}} \times \left(\left(\frac{P + P_{\text{blow}}}{P} \right)^{0.283} - 1 \right) \times h$$

Where:

BHP =	Blower power motor requirement (HP, horsepower)
f_2 =	Conversion factor for air volume to air mass
E_{blow} =	Blower efficiency (%)
P_{blow} =	Pressure at Blower outlet
h =	Air humidity correction factor
Q_{air} =	954 SCFM

$$P_{\text{blow}} = 62.4/144 \times (\text{WD} + 3.0) = 62.4/144 \times (12 + 3.0) = 6.50 \text{ psig}$$

$$E_{\text{blow}} = 78.7 - (2.11 \times P_{\text{blow}}) = 78.7 - (2.11 \times 6.50) = 65.0 \%$$

$$\text{BHP} = (((954 \times 0.068)/60) \times 53.3 \times 595) / (550 \times 0.283 \times 0.650) \times (((6.5 + 14.4)/14.4)^{0.283} - 1) \times 1.12 = 46.6 \text{ BHP}$$

Suggested Blower Size: 3 @ 30 HP (2 operating, 1 stand by)

VII. Solids Accumulation

Bacteria and other solids accumulate in areas of the lagoon in which there is insufficient energy to keep the solids in suspension. Accumulated solids will undergo a process of cumulative digestion and compaction over time. The resulting biomass/sludge is largely comprised of inert solids. For the purpose

of design, an influent inert solids concentration is utilized to calculate desludging volumes. The following equation provides an estimate of daily solids accumulation (adapted from Rich, 1999):

$$R = \frac{Q \times X_i \times 8.34}{W_s \times \rho}$$

Where:

R = Daily Accumulation Rate, cf/d

Q = Flow, MGD

X_i = Inert Solids Concentration, mg/L = 169 mg/L

W_s = Weight Fraction of Solids = 5%

ρ = Density of Water = 62.4 lbs/cf

The volume of deposited sludge in a year:

$$R_y = \frac{0.312 \times 169 \times 8.34 \times 7.48 \times 365}{62.4 \times 0.05 \times 1000000} = 0.38 \text{ MG/year}$$

Assuming that desludging will be performed at half of the settling cell volume filled

$$\text{Desludging Interval} = \frac{V_{\text{settling_cell}} \times \frac{1}{2}}{V_{\text{sludge}}} = \frac{2.56 \text{ MG} \times \frac{1}{2}}{0.38 \text{ MG/year}} = 3.3 \text{ years}$$

VIII. References

Abd-El-Bary, M.F., Eways, M.J., and Mast Engineering Co., Inc.: "Biological Nitrification in Contact Aeration Systems", *Water & Sewage Works*, June 1977.

Grady, C.P.L. Jr., G.T. Daigger and H.C. Lim: *Biological Wastewater Treatment*, Marcel-Dekker, Inc., New York, 1999.

Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers: *Recommended Standards for Wastewater Facilities (Ten State Standards)*, 1997.

Metcalf & Eddy, Inc.: *Wastewater Engineering: Treatment, Disposal, and Reuse*, McGraw-Hill, Inc., New York, 1991.

Rich, L.G.: *High Performance Aerated Lagoons*, American Academy of Environmental Engineers, 1999.

U.S. Environmental Protection Agency: *Design Manual – Fine Pore Aeration Systems*, EPA/625/1-89/023, Cincinnati, OH, September 1989.

U.S. Environmental Protection Agency: *Design Manual – Municipal Wastewater Stabilization Ponds*, EPA/625/1-83-015, Cincinnati, OH, September 1983.

U.S. Environmental Protection Agency: *Design Manual – Nitrogen Control*, EPA/625/R-93/010, Cincinnati, OH, October 1983.

Water Environment Federation: *Design of Municipal Wastewater Treatment Plants*, Manual of Practice No. 8, 1992.

Water Environment Federation: *Natural Systems for Wastewater Treatment*, Manual of Practice FD-16, 1990.

Water Environment Federation: *Aeration*, Manual of Practice – MOP FD-13, 2001.

Wastewater Data	Summer	Winter		Summer	Winter		Site Data	
Flow	0.312	0.312	MGD				Winter Air Temperature	32°F
BOD	401	401	mg/L	30	30	mg/L	Winter Air Temperature	0.0°F
TSS	371	371	mg/L	30	30	mg/L	Elevation	570 ft AMSL
Ammonia	27	27	mg/L	20	20	mg/L	Atmospheric Pressure	14.4 psia
Total Nitrogen	-	-		-	-		Distance to Site	750 miles
Phosphorus	-	-	mg/L	-	-	mg/L		

Lagoon Design

Basin # 1	
Included?	Yes
Influent Temperature	10.0 °C
Flow	0.312 MGD
Covered?	No
Water Depth	12.0 ft
Freeboard	2.0 ft
Slope	3.0 to 1
Length (waterline)	325 ft
Width (waterline)	170 ft
Length (bottom)	253 ft
Width (bottom)	98 ft
Length (at top of berm)	337 ft
Width (at top of berm)	182 ft
Cover Area	55,250 sf
Floor Area	24,794 sf
Volume	468,223 cf
Volume	3.5 MG
Detention Time	11.2 days
Selected R (Nominal)	8.0 °F-hr-sqft/BTU
Covered Basin Temp.	9.3 °C
Uncovered Basin Temp.	3.2 °C

Cell Sizing

Cell	Mixing	Det Time (d)	Depth (ft)	Winter Temp.	Rate (d ⁻¹)	CBOD ₅ In	CBOD ₅ Out	NH ₃ In	NH ₃ Out	Nitrification?
1A	CM	3.0	12.0	8.2	4.2	401	16	27.0	10.3	no
1B	SC	8.2	12.0	3.2		16	16	10.3	10.3	no

Cell	Mixing	Det Time (d)	Depth (ft)	Summer Temp.	Rate (d ⁻¹)	CBOD ₅ In	CBOD ₅ Out	NH ₃ In	NH ₃ Out	Nitrification?
1A	CM	3.0	12.0	20.0	6.0	401	14	27.0	1.7	yes
1B	SC	8.2	12.0	20.0		14	14	1.7	1.7	no

Aeration and Mixing Requirements

Cell	Mixing	CBOD ₅ (lb/d)	NH ₃ (lb/d)	CBOD ₅ (SCFM)	NH ₃ (SCFM)	Mixing (SCFM)	Benthal Air (SCFM)	Asp. Air (HP)	Sup. Mixer (HP)	Nitrification Air?	Benthal Air (%)
1A	CM	1,006	70	396	127	650	20	55	-1	Yes	10%
1B	SC	0	0	0	0	0	178	19		No	90%

Equipment Selection

Cell	Diffuser Type	Air per Diffuser (SCFM)	No. of Diffusers	No. of Laterals	Lateral Length (ft)	No. of Units	Aspirator - Hp	No. of Units	Mixer - Hp	Air Flow (SCFM)
1A	HR	18	38	5	134					684
1B	LR	9	20	4	134					180
										0
										0
Total			58	9		0		0		864

Stabilization

Estimated Stabilization Area	40,484 sf	Sludge Density	5%
Biodegradable Solids	345 lbs/d	Rate of Sludge Accumulation	0.38 MG/year
Nondegradable Solids	439 lbs/d	Desludging Volume	1.28 MG
Stabilization Loading Rate	42 g-solids/m ² /d	Desludging Interval	3.3 years

LPR Design

	Winter	
Cube Length	6 ft	
Cube Width	6 ft	
Cube Depth	10 ft	
Temperature	3.2 deg. C	
Influent CBOD ₅	16.4 mg/L	
Effluent CBOD ₅	16.4 mg/L	
BOD Load	0 lbs/d	
BOD Cube Density	48 sf/cf	
Loading Rate	0.00138 lb-CBOD ₅ /sf/d	
BOD Cubes Required	0.0 Cubes	
BOD Cube Loading Rate	0.0 lb-CBOD ₅ /kct/d	
Influent Ammonia	27.0 mg/L	
Effluent Ammonia	20.0 mg/L	
Ammonia Load	18 lbs/day	
NH3 Cube Density	68 sf/cf	
Loading Rate	0.00009 lb-NH ₃ /sf/d	
NH3 Cubes Required	8.0 Cubes	

LPR Aeration

	Winter	
Minimum Cubes	8 Cubes	
Supplemental Cubes	2 Cubes	
Total Cubes	10 Cubes	
Water Depth	12 ft	
BOD Oxygen Requirement	0 lbs/day	
NH ₃ Oxygen Requirement	83.8 lbs/day	
Total Oxygen Requirement	83.8 lbs/day	
Diffuser SOTE	1.4%	
Transfer Efficiency	16.1%	
LPR Aeration	38 SCFM	
LPR Mixing	90 SCFM	
Channels	2 Channels	
Spaces per Channel	5 Cubes	
Unused Spaces	0 Spaces	
Detention Time	3.9 Hours	

Blower Sizing

Maximum Water Depth	12 Feet	Blower Efficiency	65.0 %
Aeration Req.	954 SCFM	Blower Motor Power Req.	46.6 BHP
Mass Air Flow	1.2 lb/s	Number of Blowers	3 Units
Outlet Blower Pressure	6.50 psig	Suggested Blower Size	30 HP

City of Brandenburg
Wastewater Facilities Plan
Aeration Requirements (Historic 2014-2016 Data)
9/22/2017

Design Data

Wastewater Characteristics

Average Flow	0.232 MGD	(2014-2016)
Peak Flow	0.385 MGD	(2014-2016)
Wastewater Temp	22 °C (summer)	(assumed Aqua-Aerobic)
	12 °C (winter)	(assumed Aqua-Aerobic)
Influent BOD	401 mg/l	(2014-2016)
Influent NH ₃ N	27 mg/l	(Design)
Influent TKN	45 mg/l	(Metcalf & Eddy conversion)

Basin Dimensions

WS Length	225 ft	
WS Width	225 ft	
Bottom Length	120 ft	
Bottom Width	120 ft	
Water Depth	17.5 ft	
Side Slope	3:01	
Volume	4 MG	
Material	Lined	
Elevation	465 ft	(assumed Aqua-Aerobic)

Calculations

Hydraulic Retention Time

HRT 17.2 days

Actual Oxygen Requirement

Oxygen Demand	1.5 lb O ₂ / lb BOD
	4.6 lb O ₂ / lb TKN
AOR (BOD)	48.5 lb O ₂ / hr
AOR (TKN)	16.7 lb O ₂ / hr
AOR	65.2 lb O ₂ / hr

Field Oxygen Transfer Efficiency

FTE
$$\frac{\text{SOTE} \times [(C_s \times \beta) - C_r] \times 1.024^{(t-20)} \times \alpha}{9.09}$$

where:

SOTE	3 lb O ₂ / BHP-hr
T	22 °C
C _s	8.59 mg/l (at 22°C and 465 ft)
β	0.95 (typical, assumed)
α	0.85 (typical, assumed)
C _r	2 mg/l
FTE	1.81

Power Requirements (for BOD and TKN)

Power (aeration) 39.1 HP based on 24 hours of aeration
OK

City of Brandenburg
Wastewater Facilities Plan
Clarifier Sizing Design Calculations
9/21/2017

Flow Conditions: Q_{Avg} 0.312 MGD
 Q_{Peak} 0.9 MGD
 $Q_{Peak\ RAS}$ 0.468 MGD 150% Q_{Avg} Per 10 States

Existing Clarifiers

No. 2 diameter 36 ft A_{each} 1,018 ft²

Surface Areas Existing Clarifiers 2,036 ft²

Total Area Required Based on Surface Overflow Rate Calculation

$SA_{required} = Q_{Peak} / \text{Surface Overflow Rate at Design Peak Hourly Flow}$

Surface Overflow Rate at Design Peak Hourly Flow 1,000 gpd/ft² Per 10 States

$SA_{required}$ 932 ft²

$SA_{req} < SA_{ex}$ OK

Total Area Based on Solids Loading Rate Calculation

$Q_{in} = Q_{Peak} + Q_{Peak\ RAS}$

$Q_{in} = 1.400$ MGD

MLSS 300 mg/L Per Falmouth Design Manual (200-300 mg/l)

MLVSS 240 mg/L 80% of MLSS

SLR_{Max} 35.0 lb/day/ft² Per 10 States

$SLR = (Q_{Peak} + Q_{Peak\ RAS}) * MLSS / SA$

$SLR = 1.7$

$SLR < SLR_{Max}?$ OK